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TRANSACTIONS

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AMERICAN ENTOMOLOGICAL SOCIETY

VOLUME LXXX

TAXONOMIC NOTES ON SOME WASPS FROM FLORIDA WITH DESCRIPTIONS OF NEW SPECIES AND SUBSPECIES

(HYMENOPTERA, SCOLIOIDEA AND SPHECOIDEA)

BY KARL V. KROMBEIN

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

(Plates I and II)

The purpose of the present contribution is to describe some of the new scolioid and sphecoid wasps obtained during a collecting trip in Florida from March 29 to April 5, 1953, by a party of hymenopterists consisting of Prof. H. E. Evans of Cornell University and two of his students, C. M. Yoshimoto and Lin Cheng-Shan, Dr. W. R. M. Mason of the Division of Entomology, Canadian Department of Agriculture, and the author.[1] Additional specimens of these new forms already in the collections of the U. S. National Museum, the Academy of Natural Sciences of Philadelphia, the University of Kansas, the Canadian National Collection, and of the author, also have been included in the type series.

[1] I am indebted to Drs. Evans and Mason for the privilege of studying the material in the Scolioidea and Sphecoidea collected by the other members of our party. Mr. J. A. G. Rehn of the Academy of Natural Sciences of Philadelphia and Dr. R. H. Beamer of the University of Kansas have very kindly made available specimens from the collections in their care, and have also assisted by permitting access to or loaning certain type material. I am grateful to Dr. Ian H. H. Yarrow of the British Museum (Natural History) for his cooperation in comparing a specimen of *Gorytes dorothyae russeolus*, new subspecies, with certain of the types of *Gorytes* described by F. Smith.

In addition to the descriptions, keys are presented to aid in the differentiation of the eastern females of *Photomorphus,* the North American species of *Motes,* and the females of *Dienoplus* with largely red integument.

Family **TIPHIIDAE**

Methocha (Methocha) formosa, new species (Plate I, figs. 1, 3.)

This distinctive new species is known only from the type series of seven females collected at Arcadia, Florida, April 2–3, 1953. It is rather similar to the Cuban *M. poeyi* Guérin in having a compact ocellar triangle and very dense silvery hair on the mesopleuron, but is separated at once from that species by having the front almost flat between the eyes (best seen when viewed from above), the scutum in profile rather flat and separated anteriorly from the pronotum by a very shallow notch, a shorter median groove on the first sternite, and entirely ferruginous abdomen. It is separated from the described North American females by a combination of the compact ocellar triangle, flat front, head strongly narrowed behind eyes, profile of thorax, dense silvery hair on mesopleuron, and lack of parallel oblique rugulae on sides of propodeum (see figs. 2 and 4 of *M. stygia* (Say)).

Type.— ♀ ; Arcadia, De Soto County, Florida; April 2–3, 1953 (K. V. Krombein) [deposited in U. S. National Museum].

Female.—Length 6.4 mm. Entirely light red; except tip of mandible, last four antennal segments, and last two segments of all tarsi infuscated. Pubescence pale silvery, more or less erect and sparse except on mesopleuron and metapleuron, where it is quite dense and decumbent.

Head strongly narrowed immediately behind eyes (fig. 3) its greatest width 2.3 the width at occipital carina; clypeus with a small glabrous tubercle in middle just above the wide apical depressed rim; front almost flat between eyes (best seen when viewed from above); front and vertex with a few scattered punctures, elsewhere glabrous; ocelli in a compact right-angled triangle, the ocellocular distance twice the posterior interocellar distance.

Thorax shining except mesopleuron; pronotum no longer than combined lengths of scutum, scutellum and postnotum, in profile (fig. 1) moderately rounded, posteriorly with a few delicate, short, longitudinal carinae; scutum and scutellum subequal in length, the latter moderately rounded in profile, the former much flatter than is usual in this section of genus, very slightly convex and in profile separated from the pronotum by a very shallow notch; mesopleuron dull, finely roughened, not rugulose; mesosternum with a pair of small, low rounded projections before mid coxae; side of propodeum not rugulose.

Abdomen glabrous and with a few scattered punctures; first sternite with a shallow median groove on basal two-thirds.

MALE.—Unknown.

Paratypes.—4 ♀♀ ; same data as type [ANSP, KVK]. 1 ♀ ; Arcadia, April 2, 1953 (H. E. Evans) [HEE]. ♀ ; same data but (W. R. Mason) [CNC].

All specimens in the type series were taken crawling on the sand flats with sparse vegetation lying above and adjacent to Peace River. The paratypes vary in length from 4.3 to 6.2 mm., but do not differ in other details from the above description of the type.

Family **MUTILLIDAE**

Photomorphus alogus Viereck, 1903

Until now this species has been known from the male sex only. I captured a single male at Arcadia during the day flying low over sand moderately to sparsely covered with prostrate vegetation. One female of *Photomorphus* was taken during the day in this same habitat crawling over the sand. It is assumed that this latter specimen is probably the female of *alogus*. At least, it is distinct from females of *banksi* (Bradley) and *johnsoni* Viereck which I have taken in the vicinity of Washington, D. C., with their males, and which are the only other diurnal species likely to occur in Florida. There is one other diurnal eastern species, *rubroscutellatus* (Bradley), which is still known from the unique male type from Falls Church, Virginia, but it is most unlikely that this Florida female can be the opposite sex of *rubroscutellatus*. Males of *alogus* are now known from Georgia (type locality), Florida and Mississippi, and I have a female from Georgia in addition to the Florida female mentioned above.

The following description of *alogus* is based on the female from Arcadia, and a second female from Barwick, Georgia, October 27–30, 1951 (R. Dow) [KVK].

FEMALE.—Length 3.4-3.5 mm. Light ferruginous, the following infuscated: apex of mandible, antennal flagellum beyond first segment, fourth and fifth abdominal tergites, femora above on apical half, and tibiae except at base. Vestiture mostly silvery, rather sparse except at apex of second tergite, and on third to fifth tergites where it is denser; dorsum of head, thorax and disk of second tergite with short, brown, recumbent setae; fifth tergite in Florida specimen with very light brown hair in middle (uniformly silvery in Georgia specimen).

Mandible not dentate beneath near base, the apex acute, and inner margin with a small, acute subapical tooth; viewed from in front the head very strongly arched above the eyes; anterior margin of clypeus broadly rounded, and transverse elevated area across middle with a straight margin; antennal scrobes not carinate; front with moderately large, contiguous punctures, the lower part weakly asperate; vertex with equally large, subcontiguous punctures; viewed from above the front strongly convex between eyes; head transverse, not strongly produced behind eyes.

Viewed from above the thorax very weakly hexagonal, longer than broad (5:4), the greatest width at anterior third; dorsum with very coarse contiguous punctures; scutellar scale weakly developed and moderately narrow; dorsum behind scale and the upper third of posterior surface of propodeum moderately strongly asperate; remainder of posterior surface of propodeum with some scattered small punctures; side of pronotum with a strong anterior carina on upper half, behind this with some scattered large punctures, and interspersed, dense minute ones; metapleuron with rather sparse minute punctures; side of propodeum with scattered large and somewhat denser minute punctures.

Second tergite with discal punctures elongate, most of them separated from each other by somewhat less than the transverse diameter of a puncture; pygidium shining, with about 15 parallel carinae extending over entire length; first sternite with a sharp keel on basal two-thirds.

Photomorphus paula (Bradley), new combination

Photopsis (*Odontophotopsis*) *paula* Bradley, 1916. Trans. Amer. Ent. Soc. 42:333 (♂; Spring Creek, Decatur Co., Georgia).—Schuster, 1944. Bull. Brooklyn Ent. Soc. 39:152 (in key), 154 (♂).

Odontophotopsis paula (Bradley), Krombein, 1951. U. S. Dept. Agr., Agr. Monogr. 2:757.

Several years ago D. J. Downes, at that time a graduate student at the University of Florida, told me of his success in obtaining females of several species of nocturnal mutillids by walking over the sand at night and shining a flashlight obliquely over the ground. I tried this method the night of April 2, 1953 at Arcadia, and caught four females and two males of *Photomorphus paula* (Bradley) on the surface of sandy soil covered with sparse vegetation after nightfall between 7 and 8:30 p.m. The sand was quite cool to the touch after this time, and it is presumed that all specimens had gone back beneath the surface, for none could be found later in the evening. One of the two males collected was crawling excitedly in circles about one of the females half an inch from her. This pair (4253 C), which helps to establish the sex association in this species, has been deposited in the U. S. National Museum.

Four additional males, but no females, were attracted to gasoline lanterns operated by other members of our party during this same 90-minute period. No other species of nocturnal mutillid was collected during this time, an additional reason for supposing that the sex association based on the attraction of one of the males to a female is correct.

The female here associated with male *paula* cannot be separated generically from the females placed in *Photomorphus*. It agrees with them in such characters of generic importance as the lack of plumose hairs, ecarinate antennal scrobes, short first flagellar segment, ecarinate temples, weakly hexagonal outline of thoracic dorsum, first and second abdominal segments broadly sessile, presence of a felt line on second tergite and the lack of such a line on second sternite, and the flat, well-developed pygidium.

The male has been placed traditionally in *Photopsis* or *Odontophotopsis* because of the nocturnal habit, enlarged ocelli and mesosternal processes. Aside from the rather pale integument and enlarged ocelli, both of which are adaptations to nocturnal life, male *paula* does not differ in details of generic importance from the diurnal males placed in *Photomorphus*. It agrees with some of these, e.g., *alogus, banksi, johnsoni* (genotype) and *quintilis,* in such characters as the lack of plumose pubescence, the robust mandibles which are bidentate at apex and have a subbasal tooth on inferior margin, concave clypeus, tubercle or suberect ligulate process on mentum, unicarinate scape, presence of a pair of transverse, compound mesosternal processes, rather strongly nodose first abdominal segment, and well-developed felt lines on both second tergite and sternite.

The female has not been described previously, and the description given below is based on the series of four females taken at Arcadia.

FEMALE.—Length 4.2-5.1 mm. Pale ferruginous: mandibular apices black; head beneath, antennae, palpi and legs very pale yellow. Vestiture silvery; head, thorax and abdomen with scattered, long, erect hairs; dorsum of head, thorax and second tergite with denser, short, subdecumbent hairs; apex of second and third to fifth tergites with quite dense, short, appressed, fine hair.

Mandible slender, acute at apex, inner margin with a tiny tooth a third the distance from apex toward base, inferior margin with a strong subbasal tooth; viewed from in front the head strongly arched above eyes; anterior

margin of clypeus broadly rounded, and transverse elevated area across middle with a straight apical margin; front strongly asperate and with smaller, somewhat more separated punctures than in *alogus*; vertex with equally large, separated punctures; viewed from above the front strongly convex between eyes; head transverse, not strongly produced behind eyes.

Viewed from above the thorax very weakly hexagonal, about one-third longer than the greatest width which is at the anterior third; dorsum contiguously but more finely punctate than in *alogus*, the asperate sculpture beginning at the middle and increasing in strength posteriorly; scutellar scale weakly developed, separated in middle; posterior surface of propodeum strongly asperate on upper third or so, rather closely and shallowly punctate below; anterior margin of side of pronotum not carinate, coarsely punctate anteriorly, densely and finely so posteriorly; metapleuron with minute punctures below which become sparser above and finally absent on upper third; side of propodeum with a few large, shallow punctures.

Second tergite with punctures subcircular, small, closer than in *johnsoni*, most of those on disk separated by not much more than the diameter of a puncture; pygidium shining, with six to eight complete parallel carinae and occasionally a few short interspersed basal carinae; first sternite keeled on basal two-thirds.

The known females of the eastern species of *Photomorphus* may be separated by the following key.[2] All may be distinguished from *P. myrmicoides* (Cockerell), the only midwestern species known in the female sex, by the shining pygidium with complete parallel carinae on disk—the latter species has a dull shagreened pygidium with parallel carinae only on the basal two-thirds or less, and, in addition, a combination of edentate inferior margin of mandible and small, more or less circular punctures on disk of second tergite.

1. Inferior margin of mandible with a strong subbasal tooth; second tergite with small, more or less circular punctures on disk, most of which are separated from each other by the diameter of a puncture or more; tarsi at least, very pallid yellow, much lighter than the ferruginous thorax ..2

   Inferior margin of mandible not dentate; second tergite with larger, elongate punctures on disk most of which are separated by less than transverse diameter of a puncture; fourth and fifth tergites infuscated; tarsi ferruginous, unicolorous with thorax; diurnal forms 3

2. Third through fifth tergites, and occasionally base of second, infuscated; head and thorax darker ferruginous; most of antennae and legs infuscated; side of pronotum anteriorly strongly carinate; second tergite with appressed discal hairs dark brown; diurnal form

   P. johnsoni Viereck

[2] Schuster (Bull. Brooklyn Ent. Soc. 39:140, 147, 151, 1944) has presented keys for the differentiation of males of the eastern species.

None of tergites infuscated; head above, thorax and abdomen very pale ferruginous; antennae and legs very pale yellow; side of pronotum ecarinate; none of vestiture dark brown, entirely silvery; nocturnal form **P. paula** (Bradley)

3. First sternite anteriorly raised into a rounded prominence, not keeled; vestiture of fourth and fifth tergites mostly dark brown **P. banksi** (Bradley)

First sternite with a sharp median keel on basal two-thirds; vestiture of fourth and fifth tergites mostly silvery, that on middle of fifth sometimes slightly tinged with very pale brown ..... **P. alogus** Viereck

Pseudomethoca frigida torrida, new subspecies (Plate I, fig. 7)

Females of *P. frigida* (Smith) were relatively common. They belong to a population which is subspecifically distinct and which may be distinguished from females of typical *frigida* as follows: the smaller size, 3.5–5.0 mm. long (average 3.8 mm.), as compared to 3.8–8.2 mm. (average 5.1 mm.); paler coloration with lack of infuscation on second tergite; pale instead of dark apical fringe of first tergite; relatively sparser punctation, that on dorsum of head and thorax with well-defined interspaces which occasionally bear scattered minute punctures as contrasted to a close contiguous punctation (see fig. 6 of typical *frigida*); and the presence on the lateral margin of the thoracic dorsum of a very small, rounded projection basad of the propodeal spiracle instead of a strong acute tooth in this area.

Only one male is at hand of *f. torrida* from Florida. It is separated from males of typical *frigida* as follows: last abdominal segment ferruginous—usually the tergite always black and the sternite frequently dark also in typical *frigida*; punctures on head and abdomen comparatively sparser and finer—most of those on disk of second tergite separated by two or more times the diameter of a puncture (separated by only one diameter or less in typical *frigida*), and those on head subcontiguous instead of contiguous. A male from Jacksonville, Florida, is perhaps intermediate between the two subspecies—it has the last abdominal segment ferruginous, but the punctation is closer to that of typical *frigida.*

Type.— ♀ ; Arcadia, De Soto County, Florida; April 3, 1953 (K. V. Krombein) [deposited in U. S. National Museum]. The type (4353 A) was collected as it was crawling over the surface of sand covered with sparse, prostrate vegetation. A male, here

designated the allotype (also labeled 4353 A), was crawling excitedly in circles about her.

FEMALE.—Length 3.6 mm. Uniformly light ferruginous, the tips of mandibles, terminal flagellar segments, tibiae and tarsi in part, somewhat infuscated. Head, thoracic dorsum and second abdominal tergite with short, sparse, decumbent silvery pubescence, that on sides of thorax and third to fifth tergites denser; apical fringe of first tergite pale, of second dark brown; second tergite with some scattered, interspersed dark hairs on basal half. Punctation correspondingly sparser and finer than in typical *frigida*; dorsum of head and thorax (fig. 7) with well-developed interspaces bearing occasional minute punctures; lateral margin of thoracic dorsum with a small rounded projection basad of propodeal spiracle.

Allotype.— ♂ ; same data as type [also deposited in U. S. National Museum].

MALE.—Length 3.6 mm., forewing 2.8 mm. Black; mandibles in middle, and last abdominal segment ferruginous. Similar to typical *frigida* in vestiture and punctation, except that the latter is correspondingly finer and in some places sparser; many of those on dorsum of head subcontiguous or separated by almost the width of a puncture (usually contiguous in *f. frigida*) ; those on second tergite quite small and on disk separated by two or more times the width of a puncture (larger and usually separated by no more than the width of a puncture in *f. frigida*).

Paratypes.—2 ♀♀ ; Miami, Dade County, Florida; March 29–30, 1953 (K. V. Krombein) [KVK]. 1 ♀ ; Everglades, Collier County, Florida; April 1, 1953 (K. V. Krombein) [KVK]. 15 ♀♀ ; Arcadia, De Soto County, Florida; April 2–3, 1953 (K. V. Krombein) [ANSP, KVK]. 5 ♀♀ ; same data but April 2, 1953 (H. E. Evans) [HEE]. 7 ♀♀ ; same locality but April 2–3, 1953 (W. R. Mason) [CNC]. 3 ♀♀ ; Orlando, Orange County, Florida; April 4, 1953 (K. V. Krombein) [KVK]. 1 ♀; Ocala, Marion County, Florida; September 19–20, 1917 (Rehn and Hebard) [ASNP; determined as *P. frigida* by C. E. Mickel]. 1 ♀ ; Crescent City, Putnam County, Florida; March 27, 1896 (H. G. Hubbard) [USNM; determined as *P. frigida* by C. E. Mickel]. The paratypes vary in length from 3.5 to 5.0 mm., and otherwise are mostly very similar to the above description of the type. Paratypes have also been deposited in the collections of Cornell University and the British Museum (Natural History).

Dasymutilla chattahoochei Bradley, 1916 (Plate I, fig. 5.)

The female of this species was one of the commonest mutillids at several of the localities where we collected, such as Miami, Marco, Arcadia and Orlando. All were taken crawling over the surface of sand covered with sparse to moderate, prostrate vegetation. The male of this species has not been reported previously, and I associate with this large series of forty-five females six males collected while flying low over the surface of sand frequented by the females at Marco, Arcadia and Orlando. This sex association is not based on the similarity of preferred habitat and range alone. The males are the proper size to be the opposite sex of *chattahoochei*. Further, *chattahoochei* was the only female of its section of the Quadriguttata Group (*anguliceps* through *rugulosa*) taken by us in Florida. The male I associate with it was the only member of the Monticola Group collected. *D. rugulosa* females and *canella* males, belonging to these two groups respectively, have been recognized recently as opposite sexes of a single species.

The males run best to *arcana* Mickel in Mickel's revised key (Ann. Ent. Soc. Amer. 29: 29–39, 1936). They are distinguished from *arcana* by the truncate apical margin of median lobe of clypeus, plainly bicarinate antennal scape, presence of pale hair on head and thorax, and sparser and weaker pronotal punctation. Superficially, they are more similar in appearance to those of *macilenta* (Blake). The latter differs in a number of characters such as the bidentate apical margin of the median lobe of clypeus, unicarinate scape, and presence of a median pit filled with dense hair on second abdominal sternite.

The males of *chattahoochei* may be described as follows: Length 5.1-7.0 mm., forewing 3.9-5.1 mm. Black, the following ferruginous: first tergite, all of second and third segments, and fourth tergite in the Marco specimen; second and third segments in one Arcadia specimen; second tergite and laterally on second sternite in one Arcadia specimen and the two from Orlando. Short scattered decumbent pubescence on head, thorax and legs silvery; longer, erect, sparse hairs on head and dorsum of thorax mostly black, but with a few intermixed silvery ones; longer erect hairs on sides of thorax, propodeum, legs, first two tergites and first five sternites, silvery; the remaining tergites with both black and silvery erect hairs; apical fringes of second and third tergites black, of fourth to sixth tergites silvery. Tibial calcaria brownish. Wings moderately infuscated, the base of forewing more weakly so.

Head (fig. 5) shining, strongly narrowed behind eyes, the width at occiput subequal to postocellar distance; mandible with a large apical tooth and two small subapical teeth on inner margin; apical margin of median lobe of clypeus truncate; antennal scape strongly bicarinate beneath; first flagellar segment 0.8 as long as second; antennal scrobes not carinate above, but with a small rounded projection midway between antenna and eye; front and vertex with small, subcontiguous punctures.

Thorax shining; anterior face of pronotum slightly excavated in middle; pronotal disk with small, moderately sparse punctures in middle, becoming larger and closer at sides; scutum and scutellum with coarse, contiguous punctures; tegula not inflated, with small scattered punctures, impunctate in middle; mesopleuron anteriorly with tiny scattered punctures, over most of surface with large, shallow pits; metapleuron glabrous and with scattered, minute punctures; propodeum dorsally, posteriorly, and above laterally with moderately large, shallow reticulations, laterally below as on metapleuron.

Abdomen shining; first tergite strongly nodose, with coarse, confluent pits; marginal punctures of second tergite rather large and moderately close, more separated in center of disk; second to sixth tergites and base of seventh with close, small punctures; apical two-thirds of seventh tergite convex, glabrous and impunctate; keel of first sternite weakly concave in profile; second sternite without a median pit, with moderately large, subcontiguous punctures; third to sixth sternites with narrow apical bands of fine close punctures; last sternite not dentiform posterolaterally, but acutely angulate on apical margin in middle, the surface with sparser, small punctures.

Family **SPHECIDAE**

Nitelopterus slossonae Ashmead, 1897.

Before the date of this collecting trip I looked upon this species as one of our rarest North American sphecoids, for I had not seen over half a dozen specimens. Much to my surprise I found it to be a rather abundant form in several of the areas, particularly in Arcadia. Its apparent rarity must be ascribed to its tiny size, swift and erratic flight, and its reluctance, usually, to fly upward into a net slammed down over it.

N. slossonae is readily distinguished from the other known North American species in the genus, none of which has been recorded from east of Texas, by the much more elongate and differently shaped prothorax. In *slossonae* this is almost as long dorsally as the scutum and scutellum combined, and the posterior horizontal part is long and roughly trapezoidal in shape. In the other species the prothorax dorsally is scarcely as long as the mesoscutum, and the posterior horizontal part is short and transverse.

The present sample indicates that there is a great deal of infraspecific variation as regards coloration, though apparently a series from a circumscribed area (the present series of five females from Orlando and nineteen females from Arcadia) is quite constant in the details of coloration. While I have been unable to discern any variability in sculptural details or body proportions other than size between these series, I am of the opinion that there may be two subspecies represented here, perhaps of a primarily ethological nature. A comparison of the series of females from Orlando and Arcadia shows that the Orlando specimens are larger (average body length 5.5 mm. as compared to 5.0 mm.), have the abdomen entirely red (only the basal three or four segments red in Arcadia series), and have the antennal scapes and femora almost entirely red (these parts almost entirely infuscated in Arcadia series). Finally, and perhaps most indicative of distinct races, was the behavior of individuals of the two series—the Orlando females flew up into the net as soon as it was lowered over them, while the Arcadia females tried to escape by crawling under the rim. The technique I finally devised to capture specimens at all localities except Orlando was a quick sideward sweep with the net taking a small amount of sand with the wasp. The Orlando specimens reacted so differently, that I supposed in the field that I was dealing with a distinct form because of this different response to a similar situation.

The other females, one each from Miami and Juniper Springs, and two from Marco, differ in color from each other and from the two series described above as follows: the Miami specimen has the antennal scapes red, but the femora are rather infuscated, and the red on the abdomen dorsally is confined to the lateral and posterior margins of the first two tergites; the Juniper Springs female has the scapes largely infuscated, the femora and the first three abdominal segments red; and the two from Marco have the scapes and femora largely infuscated, and only the apices of the first two tergites are very narrowly suffused with red. All these females fall within the size range of the Arcadia series, and behaved similarly in the field.

The eighteen males from Arcadia are colored like the females except that the red on the abdomen is reduced, only the first tergite

and first three sternites being entirely red, the second tergite being at least half infuscated on disk. Only one of two males from Miami has an abdomen and it is almost entirely dark, there being only a slight suffusion with red narrowly along the margins of the first three tergites.

This species preys upon spiders, as do species of the closely related genus, *Miscophus* Jurine. I captured a female (4253 A) of typical *slossonae* with her prey, a paralyzed spider, on the sand flats covered with sparse, prostrate vegetation at Arcadia on April 2nd at 2 p.m. The spider, an immature jumping spider (Salticidae), *Metaphidippus galathea* (Walck.) [det. H. K. Wallace], was held beneath the wasp, venter to venter, the wasp clutching the spider's two forelegs near the apices between her mandibles. Kaston states (Conn. State Geol. Nat. Hist. Survey, Bull. 70: 475, 1948) that *protervus* (Walck.), which is found in the same habitats as *galathea,* is " abundant in grassy fields and on trees and bushes." The spider was as long as, and somewhat bulkier than the wasp, and the latter transported her prey awkwardly and slowly by short leaps forward. The spider's third and fourth legs on the left side, and second and fourth legs on the right side were missing beyond the coxae. Presumably these legs had been amputated by the wasp, possibly to make transport easier.

Nitelopterus slossonae barberi,[3] new subspecies (Plate II, fig. 8.)

This subspecies differs from typical *slossonae* by the size, color and ethological differences discussed above under the specific heading.

Type.— ♀ ; Orlando, Orange County, Florida; April 4, 1953 (K. V. Krombein) [deposited in U. S. National Museum].

Female.[4]—Length 5.5 mm., forewing 3.1 mm. Black, the head and thorax with strong aeneous reflections; the following light red: mandible, apical margin of clypeus, antennal scape, pedicel beneath, tegula, abdomen, legs except coxae, a small area on fore femur behind near apex somewhat infuscated. Vestiture as follows: head and thorax with very short, appressed, moderately dense, silvery pubescence; abdomen with the pubescence much

[3] For the late H. S. Barber, a sincerely mourned friend, and a peerless field naturalist who thought that ethological differences should be as important to a taxonomist as morphological ones.

[4] A detailed description is presented since typical *slossonae* has never been adequately described.

sparser, forming weak, narrow apical bands on first three tergites which are most conspicuous on the sides; tibial spurs and spines on legs black; ventral abdominal macrochaetae brown. Wings hyaline on basal two-thirds, the membrane beyond cells infumated, with iridescent reflections.

In frontal view the head more or less subcircular, with the vertex flat and not raised above eyes, the head height to greatest width as 6:7; eyes converging above, the narrowest interocular distance on vertex .6 that at level of lower rim of antennal insertions; front flat; ocellocular distance subequal to the diameter of a posterior ocellus, and three-fourths as great as the distance between posterior ocelli; head strongly narrowed behind eyes, the temples quite narrow; clypeus subshining, with height one-third greatest width, with minute, moderately close punctures except for the apical rim, the latter broadly rounded and with a narrow, moderately deep angulation one-fourth the distance from side; front and vertex dull, shagreened, granulate-appearing, and impunctate, the front in middle with a narrow, vaguely defined, short polished streak along midline; temples shining, with minute, well-separated punctures connected by a network of fine striae.

Most of dorsum of thorax (fig. 8) dull, sculptured similarly to front; pronotum elongate, five-sixths as long as scutum and scutellum together, the posterior raised part about as long as the depressed anterior part, and trapezoidal in outline, the anterior declivous part subshining; mesopleuron subopaque, the sculpture similar to that on scutum; metapleuron not set off from propodeum by a suture or difference in sculpture; propodeum with dorsal and lateral surfaces subshining, the dorsum with very fine, close transverse carinules and a central, weak keel, the lateral surface with close, parallel, fine carinules running slightly forward; posterior face of propodeum shining, above along midline with an impressed, moderately deep groove, elsewhere with weak, transverse carinae.

Abdomen with rather close, very minute punctures; sternites with subapical rows of erect, moderately long macrochaetae as follows—two on second, four on third, six on fourth and fifth, and about a dozen scattered ones on sixth.

Fore tarsal comb consisting of five spines, one each at the apices outwardly of the first three segments, and two along the side of the first; longer hind tibial spur .7 as long as hind basitarsus.

Paratypes.—1 ♀ ; Orlando, Orange County, Florida; March 29, 1953 (H. E. Evans) [HEE]. 2 ♀♀ ; same data but April 4, 1953 (K. V. Krombein) [ANSP, KVK]. ♀ ; same data but (W. R. Mason) [CNC]. The paratypes differ from the above description in no essential detail. The entire type series was taken on a sandy flat area covered with sparse to moderately dense, mostly prostrate vegetation, in a pasture adjacent to U. S. Route 17 several miles south of the city.

Motes vinulenta muspa Pate, new status

Motes muspa Pate, 1943. Canad. Ent. 75:201 (♂; Myakka River St. Pk., Fla.).—Bohart, 1951. U. S. Dept. Agr., Agr. Monogr. 2:954.

This form from Florida, proposed originally as a full species, is only subspecifically distinct from the Cuban *vinulenta* (Cresson). I have examined the lectotype male of *vinulenta* in the Academy of Natural Sciences in Philadelphia, and find that it agrees with the male of *muspa* in the vestiture and shape of the modified sternites, shape of all the femora, patch of dense, suberect, short setae on hind trochanter beneath at apex, shape and extent of flagellar tyloides, apical silvery bands on first four tergites and other characters of specific importance.

The female placed by Cresson with male *vinulenta,* actually the lectallotype because of Cresson's subsequent selection of the male as the lectotype, is incorrectly associated. The true female agrees in most essentials with the description of female *vinulenta muspa* presented below.

The populations of *v. vinulenta* and *v. muspa* differ in only a few details, but exhibit little variability as regards these characters, so a distinction may be maintained between the two forms. The wings of *v. vinulenta* tend to be suffused with yellowish, while those of *v. muspa* are brownish. The clypeus in both sexes of *v. muspa* has a rather sharp keel along midline, but is only moderately tumid in *v. vinulenta.* In addition, the clypeus of female *v. vinulenta* is very strongly tumid transversely on the median part, and only very moderately convex in *v. muspa* in this same area.

There is a strong possibility that there is a third subspecies along the Gulf Coast. I have seen a single female from Victoria, Texas, October 31, 1904 (J. C. Crawford) and two males from Harlingen, Texas, March 24, 1945 (D. E. Hardy [all USNM] which agree in all essentials with *v. muspa* as described below and in the original description. They differ from *v. muspa* in that the midline of the clypeus is only slightly tumid instead of being strongly keeled.

The female of *v. muspa* has not been described previously. The following description is based on 17 females from Seminole County, Bermont, Brighton, Arcadia, Pinellas County, and Jacksonville.

Two males from Bermont and Brighton bear the same label data as a series of females taken at each locality.

FEMALE.—Length 9-13 mm., forewing 7-10 mm. Dull black except last sternite which is mostly shining. Vestiture as in male except as follows: apical band of silvery pubescence on fourth tergite narrower; pygidium entirely covered with short, dense, subappressed brown setae, and sparse, interspersed, longer suberect setae; sternites without specialized brushes of pubescence.

Sculpture and body proportions as in male except as follows: clypeus with median height .36 the greatest width, with a strong keel in middle along midline, the surface moderately convex, not strongly transversely tumid; median lobe about half as wide as clypeus, the margin broadly and shallowly rounded, notched in middle, obtusely angulate laterally, and with a narrow, impunctate apical rim; least interocular distance on vertex three-fourths the length of scape, and .44 the interocular distance at level of lower rim of antennal insertions; lengths of scape, pedicel, and first three flagellar segments as 115 :43 :60 :70 :72; fifth to tenth flagellar segments beneath with large, oval, flat, shallowly impressed areas which are half as long as the respective segments on the fifth and sixth, and almost as long on the seventh to tenth; dorsal surface of propodeum with a median carina usually on basal three-fourths, very rarely confined to basal third or half; femora not modified; longer spur of hind tibia about 0.9 as long as hind basitarsus; pygidium slightly convex, elongate, about twice as long as basal width, the sides tapering gradually to the rounded apex; first five sternites dull and densely micropunctate; sixth sternite glossy and with scattered larger punctures except for a narrow oval strip of dense fine punctures laterally on the apical three-fourths.

Motes muesebecki,[5] new species

This new species is the fourth valid form to be recorded from Florida, and the fifth from the United States as a whole. These five may be separated by the following key, which is to serve also as a specific diagnosis for *M. muesebecki.*

1. Males 2
   Females (that of *mescalero* unknown) 6
2. Apical margin of sixth sternite bi-emarginate; fore and mid femora concave beneath on basal half; hind femur shallowly excavate beneath except at extreme base; median lobe of clypeus narrower, the apical margin more strongly rounded, not keeled along midline; first five tergites with apical bands of silvery appressed pubescence 3

[5] For C. F. W. Muesebeck, in recognition of the inspired leadership he gave to the Division of Insect Detection and Identification of the Bureau of Entomology and Plant Quarantine for so many years, and as a wholly inadequate token of my personal affection.

Apical margin of sixth sternite broadly and shallowly emarginate; fore and mid femora not concave beneath on basal half; hind femur either rounded out beneath or flattened on its entire length; median lobe of clypeus broader, the apical margin weakly rounded or subtruncate, the midline keeled or rather strongly tumid 4

3. Apical margin of sixth sternite shallowly bi-emarginate, that part of sternite between emarginations short and obtusely angulate; third to sixth sternites, except laterally, flat or very shallowly concave and clothed with a brush of moderately short, dense, suberect, dark brown hair; wings slightly infumated, more strongly so at apices; transcontinental in U. S. in Transition and Austral Zones

M. argentata (Beauvois)

Apical margin of sixth sternite very deeply bi-emarginate, that part of sternite between emarginations very narrow and elongate; third to sixth sternites, except laterally, also flat or very shallowly concave, but lacking the brush of dense hair, the fifth and sixth with similar sparser hairs; wings clear except apices slightly infumated; Lower Sonoran Fauna from southern New Mexico and southern Texas into northern Nuevo Leon .....**M. mescalero** Pate [6]

4. First four tergites with moderately broad apical bands of appressed silvery pubescence; hind femur flattened beneath; third, or sixth to seventh sternites with dense brushes of short, suberect brown hair, but without long stout macrochaetae; smaller forms, 6-9 mm. long; occurring in Florida and along Gulf Coast 5

Only the first three tergites with such bands of silvery pubescence; hind femur rounded out beneath; sternites without brushes of hair, the second to sixth with from two to four or six long, stout macrochaetae scattered across in a subapical row; larger forms, 10-14 mm. long; transcontinetal in U. S. chiefly in Austral Zone .....**M. aequalis** (Fox)

5. Third sternite with a dense brush of hair, other sternites without specialized vestiture; apex of hypopygium subtruncate; clypeus only tumid along midline; hind trochanter without brush of dense hair beneath; head and thorax rather strongly silvery pubescent; wings more weakly infumated

M. muesebecki new species

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[6] This puzzling form is an obvious derivative of *M. argentata*, or, at least, has developed from an *argentata*-like ancestor, and possibly its females are being confused with those of the latter species. I have seen several males from southern California and southern Arizona, apparently flying with *argentata* males, which have the apical margin of the sixth sternite less deeply bi-emarginate and with a more triangular, shorter process than in *mescalero* but with similar vestiture on the sternites. My opinion at present, based on very limited material, is that *argentata* and *mescalero* should continue to be recognized as discrete species, and that the males from California and Arizona, referred to in the preceding sentence, represent an undescribed subspecies of *mescalero*.

Sixth sternite laterally and all of seventh with a dense brush of hair, other sternites without specialized vestiture; clypeus keeled along midline; hind trochanter with a dense brush of suberect hair beneath near apex; head and thorax not so strongly silvery pubescent; wings rather strongly infumated with brownish .....**M. vinulenta muspa** Pate

6. First four tergites with apical bands of appressed silvery pubescence; pygidium long and narrow, twice as long as basal width, the surface convex and entirely covered with short, dense, subappressed setae and interspersed, sparse, longer, suberect setae; first five sternites dull and densely micro-punctate, the last sternite shining and with scattered, larger punctures except for areas of dense small punctures along sides; clypeus keeled along midline; Florida .....**M. vinulenta muspa** Pate

Only the first three tergites with such bands of silvery pubescence; pygidium broader, not more than a third longer than basal width, the surface flat and covered with sparser, appressed setae, and with a basal, triangular bare area except in *aequalis*; only the first three or four sternites dull and densely micropunctate, the others shining and with scattered larger punctures; clypeus at most tumid along midline 7

7. Thoracic pubescence short and erect, dark brown; wings strongly infumated with brown; pygidium without a basal, shining, impunctate area; large forms, 14.5-19.5 mm. long; transcontinental in U. S. chiefly in Austral Zone .....**M. aequalis** (Fox)

Thoracic pubescence short and appressed, silvery or cinereous; wings very weakly infumated; pygidium with a basal, shining, impunctate area; smaller forms, 7-14 mm. long 8

8. First four sternites dull and densely micropunctate; shining area across median lobe of clypeus narrow, occupying only the apical fourth or less; outer surface of hind tibia with a carina almost to base; fifth to ninth flagellar segments beneath with a small, oval, shallowly depressed area in middle; Florida and Gulf Coast ....**M. muesebecki** new species

First three sternites dull and densely micropunctate; shining area on median lobe of clypeus broader, occupying the apical third; outer surface of hind tibia carinate only on apical half; fourth through tenth flagellar segments beneath each with such a differentiated area; transcontinental in U. S. in Transition and Austral Zones ....**M. argentata** (Beauvois)

Type.—♂; Miami, Dade County, Florida; March 29, 1953 (K. V. Krombein) [deposited in U. S. National Museum].

Male.—Length 7.9 mm., forewing 6.1 mm. Entirely opaque black. Vestiture as follows: head, thorax, sides of propodeum, and legs with short, dense, appressed, fine, silvery to cinereous pubescence; first four tergites with apical bands and last tergite entirely with similar, more conspicuous silvery hair; propodeal dorsum with similar, subdecumbent, somewhat longer, dense hair; bases of first four tergites, fifth and sixth tergites, and fourth to seventh sternites with short, fine appressed brown hair; third

sternite with a dense brush of short, erect light brown hair which becomes slightly longer posterolaterally. Forewing slightly infumated with brownish, and with iridescent reflections.

Head with minute contiguous punctures; clypeus with median height one-third the greatest width, slightly tumid along midline but not keeled; the median lobe about one-third the greatest width, with a slightly rounded apical margin, rectangulate laterally, the apical margin narrowly and a narrow strip along midline impunctate; longitudinal tyloides above and below on all but first and last flagellar segments, the relative length of the scape, pedicel and flagellar segments as 100:30:40:40:42:42:40:39:35:32:30:38; least interocular distance on vertex 0.56 the length of scape, and 0.42 the interocular distance at level of lower rim of antennal insertion.

Thorax, and sides and posterior surface of propodeum with minute, contiguous punctures; dorsum of propodeum finely granulate with only a faint indication of a median carina at extreme base, separated from posterior surface by a bisinuate carina; posterior surface of propodeum laterally with a carina extending upward about a third the distance to horizontal surface.

Fore and mid femora unmodified, not shallowly excavated beneath at base; hind femur flat beneath over entire length; hind tibia on outer surface with a carina on apical three-fourths; longer spur of hind tibia subequal in length to hind basitarsus.

Second sternite convex, the apical margin very shallowly and broadly emarginate; third sternite very shallowly concave except on lateral fourth, the apical margin broadly and a little more deeply emarginate than second; succeeding sternites flat, the apical margins of fourth and fifth like that of second, those of sixth and seventh more narrowly and a bit more deeply emarginate; hypopygium flat, the sides tapering toward the subtruncate apex.

Male paratypes vary in length from 6.7 to 8.7 mm., forewing 5.1 to 5.9. Otherwise they agree quite well with the above description of the type. Most of them have no trace of a median carina on dorsum of propodeum, but in one it is moderately well developed and present on the basal half of surface.

There is a male before me of this same species from Laguna Madre, 25 mi. SW of Harlingen, Texas, March 27, 1945 (D. E. Hardy and V. L. Wooley) [USNM], which I do not include in the type series for it may represent a different subspecies. In this specimen the brush of hairs on the third sternite is about twice as long posterolaterally as in the Florida series, and there is a semicircular, recumbent brush of hairs at apex of second sternite, which is only very faintly indicated as a brush in the Florida population. There is also a discrete subspecific population in the West Indies which is apparently undescribed.

Allotype.— ♀ ; same data as type [also deposited in U. S. National Museum].

FEMALE.—Length 9.0 mm., forewing 6.1 mm. Color and vestiture as in male except as follows: only first three tergites with apical bands of silvery pubescence; pygidium, except for a triangular impunctate area at base, with short moderately dense, decumbent brown setae and a few, scattered longer, pale suberect setae; sternites without modified vestiture, the first four with short, fine, appressed brown hair, the last two almost bare.

Sculpture and body proportions as in male except as follows: clypeus with median height one-third the greatest width, slightly tumid along midline, not keeled, the surface with dense minute punctures except for the narrow band across apical margin of median lobe which is impunctate except for a few scattered larger punctures, and is about a fourth as wide as the clypeal height; median lobe about two-thirds the greatest width of clypeus, its margin broadly rounded, obtusely angulate laterally, and with a narrow, shallow emargination in middle; antennae without tyloides, but with small, oval, shallowly depressed areas on middle beneath of fifth to ninth flagellar segments; relative lengths of scape, pedicel and first three flagellar segments as 110:35:55:60:67; least interocular distance on vertex 0.44 the length of scape and one-third the interocular distance at level of lower rim of antennal insertions; propodeal dorsum without median carina; femora not modified; hind tibia with outer surface carinate on apical nine-tenths; longer spur of hind tibia about 0.9 the length of hind basitarsus; pygidium flat, 0.8 as broad as long; sternites not modified as in male, the first four dull and with contiguous minute punctures, the last two shining and with a few scattered large punctures which become somewhat denser on sixth sternite.

Female paratypes vary in length from 7.9 to 9.7 mm., forewing 5.9 to 6.7 mm., and do not vary much from the description above of the allotype. A few of them have a median carina on the basal half or less of the propodeal dorsum.

Paratypes.—1 ♀ ; same data as type [KVK]. 1 ♀ ; Bermont, Charlotte County, Florida; April 8–10, 1937 (H. I. Scudder) [KVK]. 2 ♀♀ ; Arcadia, De Soto County, Florida; April 2–3, 1953 (K. V. Krombein) [KVK]. 1 ♀, 2 ♂♂ ; same data as preceding but (H. E. Evans) [HEE]. 1 ♀ ; Manatee County, Florida; March 14, 1930 (R. F. Tinker; Fla. Fr. Fly Trap Surv.) [USNM]. 1 ♀, 1 ♂ ; Osceola County, Florida; February 3, 1930 (♀ ; R. S. Thomas) and March 11, 1930 (♂ ; J. W. Chapman); (both Fla. Fr. Fly Trap Surv.) [USNM]. 2 ♀♀, 1 ♂ ; Orlando, Orange County, Florida; April 4, 1953 (H. E. Evans) [HEE]. 1 ♂ ; same data as preceding but January 24, 1907

(A. W. Morrill) [USNM]. 1 ♀, 4 ♂♂; Orange County, Florida; January 25, 1930 (♂; R. S. Thomas), February 3–8, 1930 (♂; R. B. Mason), March 22, 1930 (♂; P. A. Ausley, Jr.), July 5, 1929 (♀, W. A. Hiers), and July 13, 1929 (♂; W. A. Hiers); (all Fla. Fr. Fly Trap Surv.) [USNM]. 2 ♀♀; Seminole County, Florida; August 1 and 29, 1929 (H. Clark; Florida Fruit Fly Trap Survey) [USNM]. 1 ♀; Juniper Springs, Marion County, Florida; April 5, 1953 (K. V. Krombein) [KVK]. 3 ♀♀; same data as preceding but (H. E. Evans) [HEE]. 1 ♀; Alachua County, Florida; March 8, 1930 (C. J. Guard; Fla. Fr. Fly Trap Surv.) [USNM]. Paratypes have been deposited also in the collections of the Academy of Natural Sciences of Philadelphia, Cornell University, and the British Museum (Natural History).

Dienoplus citipes, new species (Plates II, figs. 9, 11, 13.)

Superficially, with its almost entirely red integument, this species is very similar to *D. gyponae* (Williams), new combination [described in *Harpactus,* Kansas Univ. Sci. Bull. 8: 223, pl. 33, fig. 4, 1914 (1913)]. The latter species is still known only from the original type series of two females from Grant County in southwestern Kansas. Dr. Beamer, of the University of Kansas, has kindly loaned me the paratype of *gyponae,* and the following key will serve to separate these two species in the female sex. Since the two sexes of *citipes* are so similar in color, body proportions and punctation, it is considered probable that most of the characters used in this key will also serve to separate males of the two species. The other two described *Dienoplus* from North America are from the northwest, and are immediately separated by having the integument of head and thorax predominantly black, and in lacking ivory-colored spots on the second and fifth abdominal tergites.

Integument of body and appendages entirely light red; head behind eyes with sides subparallel for a distance (fig. 10); vertex quite broad, the distance between posterior ocelli and occiput subequal to distance between outer edges of posterior ocelli; viewed from in front (fig. 12) the vertex strongly produced above the level of eyes, the head height .9 the width; larger punctures on upper part of front larger and closer, most of them separated by once to twice the diameter of a puncture; wings clear hyaline except slightly infumated in marginal and submarginal cells; southwestern Kansas ..... **D. gyponae** (Williams)

Integument predominantly light red, though a shade darker, and with the following infuscated—antennal scape and pedicel above, flagellum, mesosternum, and above on all femora, tibiae and tarsi; head immediately narrowed behind eyes (fig. 11); vertex narrower, the distance between posterior ocelli and occiput about .8 the distance between outer edges of posterior ocelli; viewed from in front (fig. 13) the vertex broadly arcuate and not greatly produced above level of eyes, the head height, .85 the width; larger punctures on upper part of front smaller, none separated by less than three times the diameter of a puncture; wings moderately infumated with brownish, darker in marginal cell; central Florida

D. citipes new species

D. citipes was taken at Orlando and Arcadia on sandy flat areas sparsely to moderately covered with short, prostrate vegetation. It runs swiftly over the surface of the ground, takes flight readily, and is difficult to capture. Williams collected *gyponae* in a similar habitat provisioning its cells in the soil with mostly adult cicadellids, *Prairiana cinerea* (Uhler).

Type.— ♂ ; Orlando, Orange County, Florida; April 4, 1953 (K. V. Krombein) [deposited in U. S. National Museum].

Male.—Length 5.6 mm., forewing 4.2 mm. Shining, light red (a shade darker than *gyponae*); the following infuscated—apex of mandible, antenna above, mesosternum, sixth and seventh sternites, mid and hind tibiae and femora streaked above, and all tarsi; the following ivory—posterolateral quadrate spot on second tergite about half as long as tergite and a third as wide, a large median spot with narrow posterolateral elongation on fifth tergite, and stigma; the following pale yellow—clypeus, supraclypeal area, and elongate triangular spot along lower half of inner eye margin.

Head, thorax, abdomen and legs mostly with short, appressed, silvery pubescence which is quite sparse on abdomen, and densest, though only moderately so, on thorax; that on propodeum suberect, and that on scutum and third and fourth tergites pale brown. Wings slightly infumated with brownish, a bit more strongly in marginal cell; stigma ivory colored.

Head in frontal view subcircular, the height .9 its greatest width, the vertex slightly raised arcuately above the eyes; head strongly narrowed behind eyes, vertex not broad; eyes converging slightly above, the least interocular distance on vertex .9 that at level of lower rim of antennal insertion; clypeus moderately convex, its height .36 its greatest width, the anterior margin in middle subtruncate and half as wide as greatest width; front with subcontiguous, very small punctures and a few interspersed, slightly larger ones on upper part which are separated from each other by three or four times the diameter of a puncture; ocelli in a flat triangle, the distance between posterior ocelli 1.5 the distance between posterior ocellus and inner eye margin; distance between outer edges of posterior ocelli 1.5

the distance between posterior ocelli and occiput; antennae short, tyloides lacking, eighth to eleventh flagellar segments excavated beneath, the eighth and eleventh more strongly so (fig. 9) relative lengths of scape, pedicel, and flagellar segments as 50:15:20:20:18:20:20:20:20:27:20:17:30; combined lengths of scape, pedicel and first flagellar segment equal to least interocular distance on vertex.

Scutum with scattered minute punctures and very sparse larger ones separated from each other usually by three to six times the diameter of puncture; scutellum anteriorly with a transverse row of eight large foveolae, elsewhere punctured similarly to scutum; postscutellum also foveolate anteriorly and punctate elsewhere as on scutum; mesopleuron on upper third with scattered, minute punctures, below on disk with closer small punctures and some interspersed larger ones; metapleuron and propodeum except enclosure with scattered minute punctures; enclosure of propodeum an equilateral triangle with the sides slightly rounded out, with a narrow groove along midline margined by a carina, elsewhere with moderately close, minute punctures and at base a few radiating rugae.

First tergite with scattered minute punctures which are denser laterally; second tergite with more numerous minute punctures which are sparse on middle posteriorly, and with scattered larger ones; third and fourth tergites with moderately dense, small punctures; fifth and sixth more sparsely punctate; seventh with moderately close, larger punctures; second sternite punctured as is second tergite except the larger punctures are closer; succeeding sternites with moderately close, small punctures and some scattered larger ones.

Legs not modified; tarsi moderately long and slender; longer spur of hind tibia half the length of hind basitarsus.

Allotype.— ♀ ; same data as type but (H. E. Evans) [Deposited in U. S. National Museum].

Female.—Length 5.6 mm., forewing 4.2 mm. Color and vestiture exactly as in male, but lacking the light yellow markings on head, none of sternites infuscated, and the pubescence comparatively sparser.

Shape and proportions of head (figs. 11, 13) as in male except height is .85 the greatest width; distance between posterior ocelli and occiput .8 the distance between outer edges of posterior ocelli; punctation of head as in male; antennae short, flagellar segments not modified, ratio of scape, pedicel and first two flagellar segments as 50:15:22:22.

Thoracic punctation as in male.

Abdominal punctation as in male except third to fifth tergites and all sternites more sparsely punctate; pygidium flat, an equilateral triangle in shape, lateral carinae evanescent, surface with large punctures which become closer toward apex.

Legs normal for genus; longer spur of hind tibia .6 the length of hind basitarsus; comb of fore tarsus moderately long and strong, composed of five spines on basitarsus, two each on the second and third segments, and one on the fourth.

Paratypes.— ♂ ; Orlando, Orange County, Florida; March 29, 1953 (H. E. Evans) [HEE]. 2 ♂♂ ; same data but (W. R. Mason) [CNC, KVK]. ♀ ; same data but April 4, 1953 (W. R. Mason) [ANSP]. 2 ♀♀ ; Arcadia, DeSoto County, Florida; April 2, 1953 (W. R. Mason) [CNC, KVK]. The paratypes do not differ significantly from the above description except that several of the males have radiating rugae over the whole of the propodeal enclosure. The male paratypes vary from 5.1 to 5.6 mm. long, forewing length 3.9 to 4.1 mm., and the female paratypes are 5.8 to 6.7 mm. long, forewing length 4.4 to 4.9 mm.

Gorytes (Gorytes) dorothyae russeolus new subspecies

Gorytes dorothyae Krombein, 1950, described originally from coastal North Carolina and reported subsequently from Maryland, is represented in Florida by a distinctive subspecies. Known at present only in the male sex, the latter agrees with typical *dorothyae* in the shape of the head, shape and extent of the tyloides, relative lengths of the antennal segments, foveolate lower sector of metapleural-propodeal suture, and in having both the scutellum and postscutellum foveolate anteriorly. It is distinct from typical *dorothyae* in having the punctation relatively slightly denser, in the reduced yellow markings, in the presence of rather extensive ferruginous markings, and in the strongly infumated wings.

Dr. Yarrow advises me that *dorothyae russeolus* is distinct from *apicalis* and *divisus,* the only true *Gorytes* described by F. Smith from the southeastern United States.

Type.— ♂ ; Juniper Springs, Marion County, Florida; April 5, 1953 (K. V. Krombein) [deposited in U. S. National Museum].

Male.—Length 7.9 mm., forewing 7.7 mm. Shining, black; the following yellow—mandible except tip, clypeus, supraclypeal area, elongate mark along inner eye margin confluent below with the supraclypeal area and extending upward as a narrow stripe halfway from antennal insertion to anterior ocellus, scape, pedicel, posterior margin of pronotum, pronotal tubercle, posterolateral spot on scutum, scutellum, spot anteriorly above on mesopleuron beneath tegula, narrow stripe on each side of propodeum, narrow apical band on first tergite, a somewhat broader band at apex of second, and a narrower one at apex of third, and fore and mid tibiae and tarsi; the following ferruginous—antennal flagellum except last three segments, tegula, large spot laterally on propodeum surrounding the yellow stripe and adjacent to enclosure, first segment except extreme base and apex of tergite,

second tergite with a broad band across middle, basal half of second sternite, all coxae, trochanters and femora, hind tibia beneath, and hind tarsus. Vestiture similar to that of typical *dorothyae* but correspondingly denser. Wings strongly infumated with brownish, the marginal cell more strongly so; stigma yellowish; veins dark brown.

Body proportions and punctation as in typical *dorothyae*, but punctation correspondingly slightly denser, and rugae on propodeal enclosure present on all but apical fourth.

Male paratypes vary from 8.4 to 9 mm. in length, forewing 7.4 to 8 mm., and agree in most details with the type except that rugae are present on only the basal half of the propodeal enclosure. In the Gainesville paratype there is an apical yellow band on the fourth tergite in addition to the other yellow markings as detailed in the foregoing description. In the paratype labeled only Florida the second tergite is black at the base only, the second sternite is entirely red, and the third tergite lacks the narrow yellow apical band.

Allotype.— ♀ ; Lake Placid, Highlands County, Florida; April 4, 1953 (W. R. Mason; on *Opuntia* flower) [Canadian National Collection].

Female.—Length 10.5 mm., forewing 8.7 mm. Similar in punctation, coloration and vestiture to the type except that antennae and legs are entirely ferruginous, and the propodeal enclosure is rugose on basal half only.

The single female paratype is 9.5 mm. long, has a forewing length of 8.2 mm., and is similar in most details to the allotype except that the fourth tergite also has an apical yellow band.

Paratypes.— ♂ ; Lake Placid, Highlands County, Florida; April 4, 1953 (K. V. Krombein) [KVK]. ♂ ; Gulf Hammock, Levy County, Florida; April 22, 1952 (G. S. Walley) [CNC]. ♀ ; same data as preceding but (J. R. McGillis) [USNM]. ♂ ; Gainesville, Alachua County, Florida; April 29, 1928 (G. B. Merrill) [USNM]. ♂ ; Florida [ANSP].

Ectemnius (Hypocrabro) scaber rufescens new subspecies

In central and southern Florida there is a subspecies of *Ectemnius scaber* (Lepeletier and Brullé), 1835, which has the typically lemon yellow markings replaced by orange, and which has some of the areas of normally black integument replaced by red, such as the first tergite always, and occasionally the clypeus, depressed part of pronotum, scutellum and propodeum. Typical *scaber,* as

represented at the type locality (Philadelphia, Pa.), and by specimens from New Jersey [ANSP], Virginia [ANSP], coastal North Carolina [KVK], Oklahoma [USNM] and Texas [USNM, KU, ANSP], has ferruginous on the legs only, and the pale markings are lemon yellow.

There is a wide zone of intergradation between *s. scaber* and *s. rufescens*. Of four males labelled "Ga." [ANSP], two are typical *scaber,* and two are intermediate having some red on pronotum, scutellum, and first tergite, but the pale markings are lemon yellow. A male from Tifton, Georgia [USNM] has red on the clypeus, pronotum, scutellum and first tergite, but the pale markings are lemon yellow. A female from Hibernia, Florida [KU] has some red on thorax and first tergite, but the pale markings are mostly yellow. Of four males from Gainesville, Florida [USNM], one would be placed in *s. rufescens,* but the other three would fit best in *s. scaber*—these have no ferruginous integument except the legs, but their pale markings tend toward orange (cyanided?). In a series of nine specimens from Creole, Louisiana [USNM, KU], two females and five males are typical *scaber,* but two males have red at apex of scutellum, and on basal two-thirds of first tergite, and lemon yellow markings. A male from New Orleans and a female from Baton Rouge, both Louisiana [USNM], are typical *scaber.* I have not included in the type series of *s. rufescens* any of the specimens coming from localities where there is, supposedly, an intergrade population.

Type.—♂ ; Marco, Collier County, Florida; April 1, 1953 (H. E. Evans) [deposited in the U. S. National Museum].

MALE.—Length 9.1 mm., forewing 7.4 mm. Black; scape lemon yellow; the following orange—band on pronotal dorsum, pronotal tubercle, postscutellum, broad band across middle of second tergite, narrow transverse bands across middle of third to fifth tergites increasing slightly in width on successive tergites, that of third broadly interrupted three times, transverse spot in middle of sixth tergite, fore femur at apex above and entirely beneath, fore tibia above, mid femur at apex above; the following red—anterior declivous surface of pronotum, tegula, apex of scutellum, first tergite except narrowly at base and apex, and legs except for the orange areas. Vestiture and punctation as in typical *scaber*, but wings a bit more infuscated.

Male paratypes vary in length from 7.9 to 8.4 mm., forewing 6.4 to 6.9 mm. The specimen from Everglades has apical half of

clypeus and scutellum except extreme base also red, and orange markings are lacking on third tergite and reduced on fourth and fifth. One of the males from Lacoochee agrees almost exactly with the type. The other has the clypeus entirely, pronotum entirely except for orange areas, all but base of scutellum, and small spot anterolaterally on propodeum also red.

Allotype.— ♀ ; Lake Placid, Highlands County, Florida; July 13, 1948 (E. L. Todd) [USNM].

Female.—Length 10.9 mm., forewing 8.5 mm. Coloration as in male type except third tergite with only a tiny lateral orange spot, band on fourth interrupted laterally and none on sixth, and scutellum entirely red except extreme base. Vestiture and punctation as in typical *scaber*. Wings a shade less infuscated than in male type.

The single female paratype is 10.2 mm. long, forewing 7.9 mm., and agrees very well with the allotype in other details except that there is a larger amount of red on the pronotum, and a small blotch of red laterally on propodeal dorsum.

Paratypes.—1 ♂ ; Everglades, Collier County, Florida; April 1, 1953 (C. M. Yoshimoto) [HEE]. 1 ♀ ; Ochopee, Collier County, Florida; June 23, 1951 (Beamers, Price, Wood) [KU]. 1 ♂ ; Lacoochee, Pasco County, Florida; July 7, 1947 (R. H. Beamer) [USNM]. 1 ♂ ; same data as preceding but (R. T. McDermott) [KU].

Explanation of Figures

(All illustrations by Arthur D. Cushman)

Plate I

Fig. 1.—*Methocha* (*Methocha*) *formosa*, new species. Female (type). Arcadia, Florida; April 2-3, 1953 (K. V. Krombein). Lateral view of thorax. (X 25.)

Fig. 2.—*Methocha* (*Methocha*) *stygia* (Say). Female. Manhattan, Kansas; July 16, 1950 (H. E. Evans). Lateral view of thorax. (X 25.)

Fig. 3.—*Methocha* (*Methocha*) *formosa*, new species. Female (type). Arcadia, Florida; April 2-3, 1953 (K. V. Krombein). Dorsal view of head. (X 25.)

Fig. 4.—*Methocha* (*Methocha*) *stygia* (Say). Female. Manhattan, Kansas; July 16, 1950 (H. E. Evans). Dorsal view of head. (X 25.)

Fig. 5.—*Dasymutilla chattahoochei* Bradley. Male. Marco, Florida; April 1, 1953 (K. V. Krombein). Frontal view of head. (X 25.)

Fig. 6.—*Pseudomethoca frigida frigida* (Smith). Female. Woods Hole, Massachusetts; August 24, 1946 (K. W. Cooper). Dorsal view of thorax. (X 25.)

Fig. 7.—*Pseudomethoca frigida torrida*, new subspecies. Female (type). Arcadia, Florida; April 3, 1953 (K. V. Krombein). Dorsal view of thorax. (X 25.)

Plate II

Fig. 8.—*Nitelopterus slossonae barberi*, new subspecies. Female (type). Orlando, Florida; April 4, 1953 (K. V. Krombein). Dorsal view of thorax and wings. (X 25.)

Fig. 9.—*Dienoplus citipes*, new species. Male (type). Orlando, Florida; April 4, 1953 (K. V. Krombein). Lateral view of last six segments of antennal flagellum. (X 50.)

Fig. 10.—*Dienoplus gyponae* (Williams). Female (paratype). Grant County. Kansas, 2300 ft.; July 25, 1911 (F. X. Williams). Dorsal view of head. (X 25.)

Fig. 11.—*Dienoplus citipes*, new species. Female (allotype). Orlando, Florida; April 4, 1953 (H. E. Evans). Dorsal view of head. (X 25.)

Fig. 12.—*Dienoplus gyponae* (Williams). Female (paratype). Grant County, Kansas, 2300 ft.; July 25, 1911 (F. X. Williams). Frontal view of head (tipped slightly forward to show development of vertex). (X 25.)

Fig. 13.—*Dienoplus citipes*, new species. Female (allotype). Orlando, Florida; April 4, 1953 (H. E. Evans). Frontal view of head (tipped slightly forward to show development of vertex). (X 25.)

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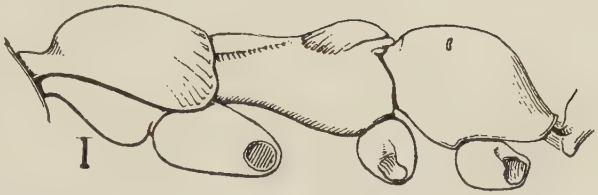
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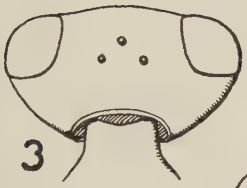
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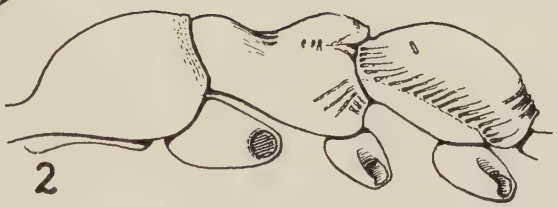
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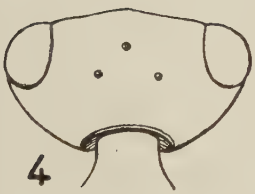
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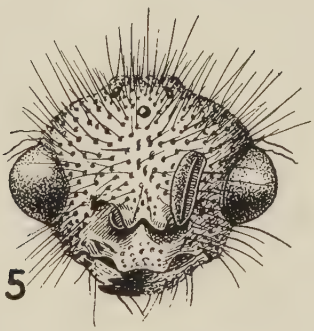
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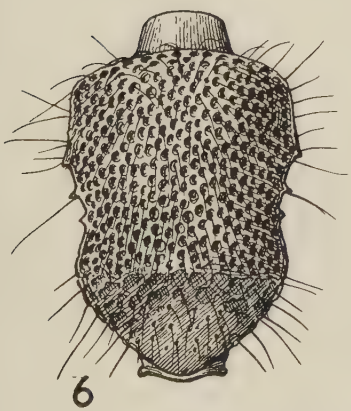
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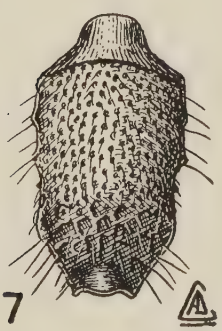
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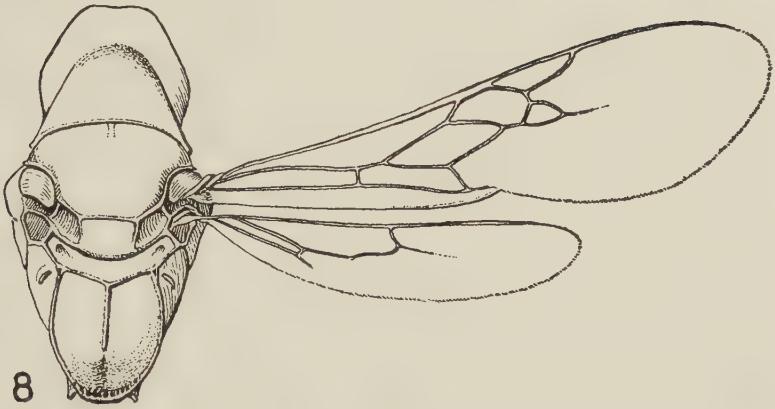
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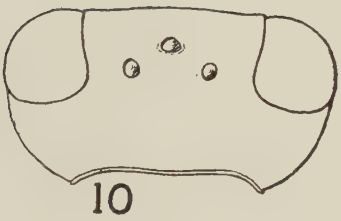
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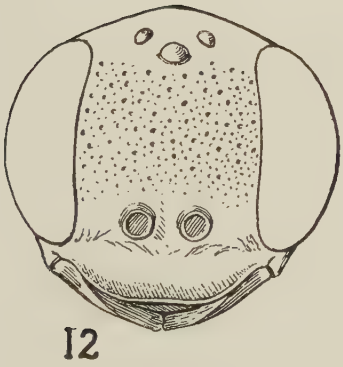
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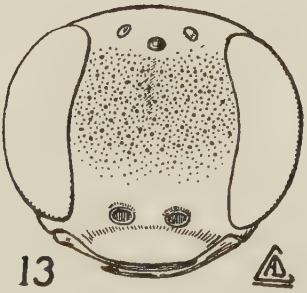
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ANASTATUS FLORIDANUS (HYMENOPTERA: EUPELMIDAE) A NEW PARASITE ON THE EGGS OF THE COCKROACH EURYCOTIS FLORIDANA

BY LOUIS M. ROTH AND EDWIN R. WILLIS

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(Plates I-III, Text-fig.)

In late December 1952, one of us (L. M. R.) together with Marc Roth collected several adults and oöthecae of *Eurycotis floridana* (Walker) in St. Petersburg, Florida. On February 8, 1953, 65 ♀ and 3 ♂ Hymenoptera emerged from 2 holes made through the side of one of the egg cases. Several of the wasps were submitted for determination to Dr. B. D. Burks of the U. S. National Museum, Washington, D. C. who informed us that the wasp was ". . . an undescribed species of the eupelmid genus *Anastatus,* near *blattidarum* Ferrière. Mr. Gahan segregated specimens of this species in our collection several years ago as *Anastatus* sp. W. The specimens of this ' sp. W ' already in our collection were reared from the egg case of an undetermined roach collected at Indian River, Florida."

Anastatus blattidarum Ferr., a parasite in the eggs of *Supella supellectilium* (Serv.) (brown-banded roach), was first recorded from the Anglo-Egyptian Sudan (Ferrière, 1930, 1935) and has since been found in Hawaii (Weber, 1951) and Arizona (Flock, 1941). The U. S. National Museum collection also has specimens from Louisiana, Texas, Virginia, District of Columbia, and Florida as well as Mysore and Coimbatore, India (Burks, 1953). *Anastatus blattidifurax* Girault was reared from an oötheca of an unidentified cockroach in Australia (Girault, 1915).

Eurycotis floridana has been recorded from Georgia, Florida, and Mississippi, where it is found in outdoor sheltered areas such as stumps, under signs, bark of dead trees (Hebard, 1917), and

corded wood (Dozier, 1920). Friauf (1953) has collected *Eurycotis floridana* in 5 types of habitat in northern Florida: this species was one of the dominant Orthoptera in xeric hammock vegetational associations, frequent in the mesic hammock habitat, and infrequent in the sandhills habitat; in moister situations it was infrequent in the saw grass marsh habitat, but was one of the dominant Orthoptera in low or hydric hammocks.

Our specimens were collected in a trash dump where the species was very numerous. The Australian cockroach was also present in this dump. Occasionally *Eurycotis* was found to enter houses where their large size and stout appearance cause considerable consternation among the occupants, even though few specimens may be seen indoors.

About 24 adult *Eurycotis* were brought back to our laboratory from Florida, and a colony of this species has been established. The insects have been maintained and reared on Purina Dog Chow Checkers. In the laboratory the formation of the oötheca (Plate I, figs. 1-6) may be completed in about 6 hours, after which it is carried by the female until it is deposited about 18 hours later. The oötheca is formed with its keel directed dorsally and remains in this position as long as it is attached to the female (Plate I, figs. 5, 6). The female may or may not cover the dropped oötheca with debris (e.g., paper, food); when the egg case is covered, the material used is chewed into a paste and spread over the egg case. The oviposition behavior is in general similar to that of the American and oriental cockroaches.

The oötheca of *Eurycotis floridana* is comparatively large, the average size being 13 mm. long and 8 mm. high (Lawson, 1953). Of 100 oöthecae isolated from our culture, the average number of eggs per oötheca was 23 (minimum 15, maximum 25). The average percent hatch from an oötheca was 96 (based on 100 oöthecae from which some or all the eggs hatched). Sometimes abnormally small oöthecae, containing less than 15 eggs, are formed. At about 85° F. the eggs hatch in from 48 to 51 days.

Sufficient cockroach eggs were obtained to maintain the parasite, and it was carried through several generations. Following the description of this new eupelmid parasite, we present various biological data.

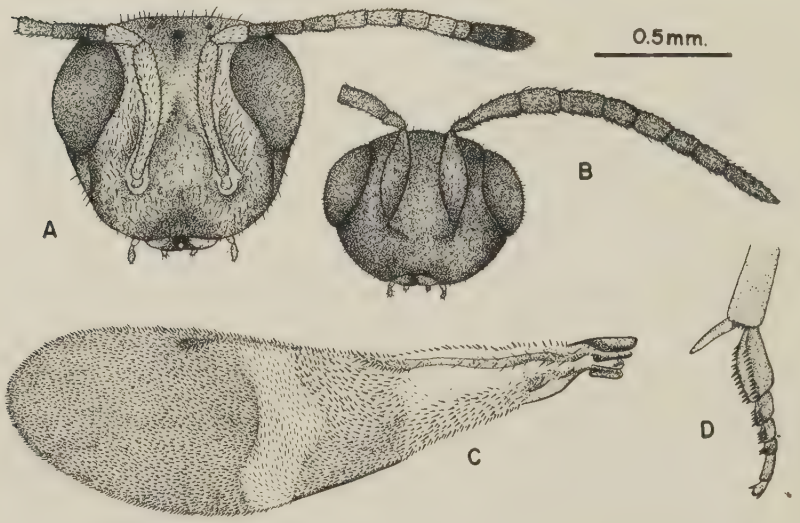
Anastatus floridanus, new species (Plate II, figs. 7-9; Text-fig. 1.)

Female.—Length 2.0-4.1 mm. Head and thoracic sclerites rusty yellow-brown with purplish reflections. Abdomen brownish-black with purplish reflections except for the basal two segments which are largely whitish; baso-dorsal and dorso-lateral surfaces of the first abdominal segment brownish, and two small dorso-lateral spots and apical margins on second abdominal segment brownish. About basal half (hidden in abdomen) of the valvae dark-brown followed by a narrow hyaline stripe, the remainder brownish-yellow. First 3 antennal flagellar segments darkened and club (sometimes segment 10 also) blackish, the scape, pedicel, and remaining flagellar segments yellowish-brown. Coloration of forewing (Text fig. 1, C) as follows: small basal portion brown followed by a hyaline area, then a band partly brownish-yellow and partly brown, then an almost median hyaline irregular stripe, finally followed by a broad brown outer region, with iridescent reflections. Except for a small area near the base, the wing is covered by cilia, those in the irregular hyaline stripe being colorless whereas the others are in the main dark. Posterior wing hyaline with iridescent reflections, long cilia on the posterior margin; surface cilia on apical half darker and more dense than those on basal half. Legs brownish, a thick patch of broad pale setae on anterior surface of hind coxa.

Head (Text fig. 1, A) viewed from in front wider than high. Cheeks converging slightly, eyes finely but sparsely pubescent. Scrobe moderately deep, marginate, extending about half the distance between the antennal fossae and median ocellus. Except for the scrobes, head sclerites covered with fine setae. Mesoscutum slightly longer than scutellum. Parapsides and scutellum strongly sculptured. Gaster about one-third longer than thorax. Ovipositor extending slightly beyond gaster.

Antennae 13 segmented, inserted below the level of the ventral margins of the compound eyes. Scape slightly curved, about as long as the pedicel and first 3 flagellar segments combined, reaching the level of the median ocellus. Pedicel about twice as long as broad. First flagellar segment subquadrate, about half as long as second; flagellar segment 8 slightly wider than long. Club almost as long as the 3 preceding segments combined. Ocelli forming an obtuse triangle; postocellar line longer than ocellar line. Forewing (Text fig. 1, C) about 3 times as long as broad. The mid-tarsal segments 1-4 each with 2 rows of short stout spines (Text fig. 1, D). About 3 or 4 short stout spines (similar to those on the tarsal segments) near the calcarium of the mid-tibia.

Male.—Length 1.5-2.7 mm. Head, thorax, and abdomen entirely dark, with greenish and purplish reflections. Scape brown except for a pale basal and vertical grooved area. Pedicel and flagellar segments blackish. Front, mid, and hind femora dark except for small pale basal and apical areas, the pale areas on the front femur more extensive than on the other two. Apical halves or less of the front, mid, and hind tibiae brownish, the remaining parts



Text-figure 1.—Parts of *Anastatus floridanus*. A, Head of ♀ (front view); B, Head of ♂ (front view); C, Forewing of ♀; D, Tarsus and apex of tibia of midleg of ♀. (Drawn from alcoholic and slide-mounted specimens.)

of the tibiae and tarsi yellowish: the dark portions of the mid and hind tibiae more distinct and extensive than those of the front tibiae. Wings hyaline, with iridescent reflections, covered with cilia.

Head, thorax, and abdomen setose. Head (Text fig. 1, B) viewed from in front more or less elliptical. Antennae 11 segmented, inserted slightly above the level of the ventral margins of the compound eyes. Scape reaching to about the level of the upper margin of the head. Pedicel subtriangular, about one-half the length of the first funicular segment; one minute ring segment; pedicel and flagellar segments about as long as head and thorax combined.

Type locality.—Snell Isle, St. Petersburg, Florida.

Types.—U.S.N.M. no. 62211

Described from a series of alcoholic, pinned, and slide-mounted specimens. The original parasites were reared from an oötheca of *Eurycotis floridana* collected December 28, 1952 (L. M. Roth). The specimens used for the descriptions were laboratory-reared offspring from these original wasps. The ♀ holotype, ♂ allotype, and 8 ♀ and 5 ♂ paratypes, have been deposited in the U. S. National Museum; in addition 19 ♂ and 12 ♀ specimens mounted on slides, not included in the type series, are deposited in the U. S.

National Museum collection. Two ♂ and 8 ♀ paratypes deposited in the Academy of Natural Sciences, Philadelphia, Pennsylvania.

Some differences between the females of *Anastatus floridanus* and *A. blattidarum* are listed below:

	Anastatus floridanus	*Anastatus blattidarum*
Host	*Eurycotis floridana*	*Supella supellectilium*
Head	Yellow-brown	Shining green
Antennae	Yellow-brown except for darkened first 3 flagellar segments and black club; scape short (reaching level of anterior ocellus) and expanded toward apex	Brown with scape and pedicel yellow; scape long (much exceeding level of vertex) and narrow throughout
Thorax	Yellow-brown; anterior part of mesonotum almost smooth	Orange-yellow; anterior part of mesonotum rugose
Abdomen	Brownish-black with purplish reflections, first and second segments largely whitish	Aeneous-black, with dark-green shine near apex, first and second segments largely whitish
Valvae of ovipositor	Basal half dark-brown followed by a narrow hyaline stripe, remainder brownish-yellow	White

The abdomen of *A. blattidifurax* is dark metallic blue except for a white band at the base (Girault, 1915).

Biology of *Anastatus floridanus*

Mating.—The wasps begin to mate immediately after they emerge from the oötheca. If the males emerge first, they show considerable "excitement" around the emergence hole; a male was observed extending his abdomen into the emergence hole prior to the issuance of the females. The females are sexually receptive almost immediately on leaving the cockroach egg case; they raise the tips of their abdomens and extend the triangular basal portions of their ovipositors. This apparently is a "calling" position and may have to do with the emission of a sex odor. The male mounts the female and clings to the end of her abdomen while he bends

his abdomen anteroventrally and impregnates the female. Mating takes 3 to 4 seconds. The males mate repeatedly and may fertilize several females; females may also assume the calling position after mating and may copulate more than once.

Oviposition.—The female initially "probes" the oötheca with the tip of her sheathed ovipositor. On finding an acceptable spot she unsheathes the ovipositor (Plate II, fig. 7) and drills a hole through the wall of the oötheca. After penetrating the oötheca she inserts the sting up to its base (Plate II, fig. 8). While the wasp is ovipositing, her antennae are directed forward and downward and vibrate repeatedly. One female was seen ovipositing for about 5 hours, but briefer periods of oviposition were also observed. One female was seen to feed on the material which oozed from the puncture made by her ovipositor. Insertion of the ovipositor into the oötheca gives no assurance that the eggs will be parasitized; in a few instances female wasps were seen to pierce the oötheca, but the cockroach eggs were not parasitized.

The female wasp will oviposit not only in oöthecae that have been dropped by the cockroach (eggs as old as 36 days were successfully parasitized), but also in egg cases that are being formed and are still attached to the female *Eurycotis* (Plate II, fig. 9). When oötheca-bearing cockroaches are exposed to the adult female parasites, the wasps orient with heads toward the blattids and approach them with rapidly vibrating antennae. The wasps hop up on the oötheca, or if they climb on to the body of the cockroach, they may crawl to the oötheca. Once the wasps touch or crawl on the cockroach, the blattid makes repeated efforts to brush them off with her hind legs. The cockroach may also keep her antennae in contact with the substrate and sweep them back and forth; she attempts to catch the wasps, and if successful eats them. On several occasions we observed a female cockroach catch and eat wasps when confined with them in a glass chamber 10 cm. in diameter. Once the wasp inserts her ovipositor into the attached oötheca, the cockroach usually remains quiescent and makes no attempt to dislodge her. The wasps will also orient toward male and non-oötheca-bearing female *Eurycotis*. Cros (1942) observed that *Blatta orientalis* L. will pursue the females of *Prosevania punctata* (Brullé), a wasp which parasitizes the eggs of the oriental and American cockroaches.

Developmental period.—At about 85° F. the wasps complete their development in from 34 to 46 days after the eggs are deposited; this is somewhat less time than is required for development of the cockroach eggs. Some of this variation may be caused by differences in the numbers of wasps developing within the oöthecae (Table 1.) When fewer wasps develop within an oötheca, they take a longer period of time to consume the greater amount of available food.

TABLE 1

Relation Between Duration of Developmental Period and Size of Broods of *Anastatus floridanus* in Oöthecae of *Eurycotis floridana*

Number of Wasps Per Oötheca			Duration [1] (Days) of Developmental Period			Number of Oöthecae
Min.	Max.	Mean	Min.	Max.	Mean	
23	57	45	39	46	41.5	10
64	306	189	34	39	36.4	36

[1] From day of exposure of the oötheca to the female wasps till emergence of the offspring.

Number of wasps developing in an oötheca and effect on host.—Table 2 shows the number of wasps which may develop in the eggs of *Eurycotis* after the oöthecae have been exposed to either a single or many female parasites. A single female wasp may produce an average of 50 offspring, which is considerably less than the large number of large eggs, in the oötheca of *Eurycotis,* can actually support. After exposure to numerous female wasps, more than 300 parasites may develop on the eggs contained in a single oötheca. It is probable that at times either the first-hatched wasp larvae eat unhatched wasp eggs or the larvae eat one another. For example, 4 oöthecae were each exposed to 50 female wasps and then dissected one week later. These oöthecae contained from 388 to 709 (average of 601) wasp larvae, considerably more than the maximum number (306; see Table 2) of wasps reared to maturity from oöthecae exposed to many females. Two oöthecae, each exposed to 50 female wasps and kept until the parasites emerged, produced only 176 and 167 wasps respectively. These data indicate that cannibalism may occur among the developing wasp larvae

if too many wasp eggs (for the available food) are deposited into one oötheca.

TABLE 2

Size of Broods of *Anastatus floridanus* from *Eurycotis floridana* Oöthecae Exposed to Single and Many Wasps

Note: The oöthecae were exposed for the entire life of the wasps

Oöthecae Exposed to	Total Number[1] Wasps Per Oötheca			Mean Numbers ± S.E.[2] of		Ratio	Number of Parasitized Oöthecae
	Min.	Max.	Mean ± S.E.	♀♀	♂♂	♀ : ♂	
Single wasps	23	81	50 ± 6.4	38 ± 6.8	9 ± 0.4	4.2 : 1	8
Many wasps	93	306	198 ± 8.0	126 ± 4.6	65 ± 8.0	1.9 : 1	34

[1] Includes the small number of larvae or pupae which failed to complete their development and remained in the oötheca.
[2] Standard Error.

In general all of the cockroach eggs are eaten by the wasp larvae, but even if some of the eggs are uneaten (Plate III, fig. 11), they usually fail to hatch, and the fully matured cockroach embryos die in the oötheca after the wasps have emerged. In one instance 5 cockroach nymphs hatched from a parasitized oötheca which had been exposed to wasps 27 days after the egg case had been dropped by the *Eurycotis;* 23 wasps developed and 5 cockroach embryos were uneaten but failed to hatch. One oötheca in which we saw a wasp insert her ovipositor yielded only 2 wasps (1 adult ♀ and 1 larva) ; ten cockroaches hatched out, and on opening the oötheca we found each of the 2 wasps in the space formerly occupied by a single cockroach egg ; 1 well-developed embryo and 11 undeveloped cockroach eggs remained in this oötheca. Apparently the one adult wasp had matured on one or possibly one and part of a second *Eurycotis* egg. Uneaten cockroach eggs are usually found in oöthecae containing few wasp larvae.

The wasps make from 1 to 6 (Plate III, fig. 10) emergence holes in the oötheca ; of 42 parasitized egg cases the average number of emergence holes was 2. Frequently more than one wasp may begin chewing an emergence hole, but when one hole is com-

pleted the other wasps stop chewing and leave through the finished opening. When the wasps emerge from the cockroach oötheca, their antennae are still covered by the pupal skins; they shed these skins just after emergence. The pupal skin other than that covering the antennae remains in the oötheca.

Sex ratio and parthenogenesis.—The wasps issuing from cockroach eggs exposed to one mated female are preponderantly female, averaging about 4 females to 1 male (Table 2). Undoubtedly the larger proportion of males emerged from oöthecae exposed to many wasps because some of the ovipositing females had not mated and the eggs from these individuals produced only males.

Two *Eurycotis* oöthecae were exposed to 13 unmated *Anastatus* females which we removed, prior to emergence, from an oötheca. Only one of these oöthecae yielded parasites: 42 males and 7 larvae. In another experiment 35 female wasps emerged from an oötheca which did not contain any male parasites. Three *Eurycotis* oöthecae were exposed to these females, and two of them later yielded parasites: a total of 591 adult males and 10 immatures; no adult females developed. *Anastatus floridanus* can reproduce parthenogenetically, the offspring apparently being all males (arrhenotoky); this is also true for *Anastatus blattidarum* (Flock, 1941).

Size of adults.—The size of the adult wasps varies, and depends on the amount of available food; thus when very few individuals develop within an oötheca, the adults are comparatively large on emergence. This is shown in Table 3 where antennal and tibial measurements are given for random samples from 2 groups of wasps in which the numbers of wasps that developed within two oöthecae differed by a factor of 6.8; the size differences between the 2 groups are highly significant.

TABLE 3

Effect of Parasite Density Within the *Eurycotis* Oötheca on the Size of Adult Females of *Anastatus floridanus*

Number of Wasps in Oötheca	Mean Length (mm.) ± S.E.[1] of Antenna [2]	Hind Tibia	Number of Wasps Measured
35	1.34 ± 0.009	1.08 ± 0.005	15
238	1.12 ± 0.011	0.83 ± 0.009	15

[1] Standard Error.
[2] Includes only the combined length of the pedicel and flagellar segments.

Longevity.—The adult wasp is short-lived. At about 80° F., females lived from 2 to 4 days and males only 1 day (these wasps were supplied with moist raisins).

Host specificity.—The oöthecae of three other species of cockroaches were exposed to large numbers of female *Anastatus floridanus.* None of 40 oöthecae of *Supella supellectilium* was parasitized. Nine (6%) out of 152 oöthecae of *Periplaneta americana* (L.) were parasitized. One out of 111 oöthecae of *Blatta orientalis* L. was parasitized; 44 female and 4 male adult wasps were obtained from this egg case and these were given 10 oriental oöthecae. None of the eggs in these latter oöthecae was parasitized. Apparently *Anastatus floridanus* is specific for *Eurycotis floridana,* and only rarely, under experimental conditions, will it parasitize the eggs of the American or the oriental cockroach, even though the wasp is capable of developing on the eggs of these blattids. *Anastatus blattidarum* seems to be specific for the eggs of *Supella supellectilium* and will not oviposit in the eggs of *Latiblattella lucifrons* Heb., *Periplaneta americana, Blattella germanica* (L.) and *Blattella vaga* Heb. (Flock, 1941). However, there are specimens of *A. blattidarum* from India in the National Museum collection which are said to have come from *P. americana* (Burks, 1953).

The stimuli involved in finding and ovipositing into cockroach eggs by wasp parasites are unknown. Edmunds (1952) noted that the evaniid *Prosevania punctata* paid more attention to oöthecae which the American cockroach cemented to the walls of the cage than to egg cases that were merely dropped and left uncovered. Cros (1942) observed this same species of parasite dig deep excavations with the front legs to bare oöthecae which were buried in sand; this behavior would indicate that an olfactory stimulus was involved in locating the host oötheca. In one experiment we covered *Eurycotis* oöthecae with a layer of sand, and in another experiment with sawdust, then placed about 100 *Anastatus* in each of the dishes. None of the eggs was parasitized; however, one of the oöthecae in the sawdust was partly uncovered, apparently by the wasps.

Ten American cockroach oöthecae were smeared with a " paste " made of wet sand and ground up empty (the cockroaches had

hatched) *Eurycotis* oöthecae and exposed to many female wasps; none of these eggs was parasitized. Ten American oöthecae were smeared with saliva and chewed filter paper taken from a female *Eurycotis* in the act of covering her deposited egg case. After exposure to the wasps, 3 (30%) of the oöthecae contained parasites; 33 female wasps (plus several males) reared from these American oöthecae were exposed to 30 untreated American oöthecae; none of these eggs was parasitized. Although the number of oöthecae used in the saliva experiment was small, the results may indicate the presence of a substance in the saliva of *Eurycotis* females which may induce *Anastatus* to oviposit. It should be noted that the wasps reared from the eggs of the American and oriental cockroaches later failed to parasitize oöthecae of these 2 species. Evidently host specificity cannot be reduced in one generation by rearing this parasite on unnatural hosts.

Summary

A new wasp *Anastatus floridanus,* which is parasitic on the eggs of *Eurycotis floridana,* is described. The wasp can reproduce parthenogenetically and apparently is arrhenotokous. The sex ratio of offspring from mated females is about 4 females to 1 male. The female may oviposit through the still-soft walls of an oötheca that is being formed and carried by the cockroach or through the hardened oötheca containing eggs more than a month old. Wasp development takes 34 to 46 days, the developmental time being determined to some extent by the number of parasites in the oötheca. The female wasp produces an average of about 50 offspring, but more than 300 wasps can develop on the eggs contained in a single oötheca of *Eurycotis.* All of the cockroach eggs are usually eaten by the wasp larvae, but if too few parasites are present, some of the eggs may not be eaten and may complete their development; however, these generally fail to hatch. The size of the wasps is variable being largely determined by the amount of available food; there is some evidence that the larvae are cannibalistic. The adult wasps are short-lived, the males living about 1 day and the females about 2 to 4 days. *Anastatus floridanus* can develop on the eggs of the American and oriental cockroaches but will not oviposit into these eggs readily; the wasp will not oviposit into the eggs of *Supella supellectilium.*

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Explanation of Plates

Plate I

A female *Eurycotis floridana* in the process of forming an oötheca. Time in hours (hrs.) and minutes (min.) taken from the time the oötheca was first visible.

Fig. 1, 1 hr. 30 min.; fig. 2, 2 hrs. 20 min ; fig. 3, 3 hrs. 40 min.; fig. 4, 4 hrs. 10 min.; fig. 5, 20 hrs. 22 min.; fig. 6, 21 hrs. 5 min.; (Figs. 1-5, dorsal views; fig. 6, lateral view; all about natural size.)

Plate II

Anastatus floridanus ovipositing into the eggs of *Eurycotis floridana.*

Fig. 7, Wasp beginning to pierce a dropped oötheca with her unsheathed ovipositor. X 13.3; fig. 8, Wasp with her ovipositor inserted through the wall of the oötheca. X 13.3; fig. 9, Wasp ovipositing into an oötheca which is being formed and is still attached to the female cockroach. X 3.

Plate III

Oöthecae that contained eggs of *Eurycotis* that were parasitized by *Anastatus floridanus.* X 5.8. Fig. 10, four of 6 emergence holes visible in oötheca; fig. 11, Oötheca opened to show destruction of all but 4 cockroach eggs; 4 well-developed cockroach embryos were still alive in the oötheca after the adult wasps had emerged.

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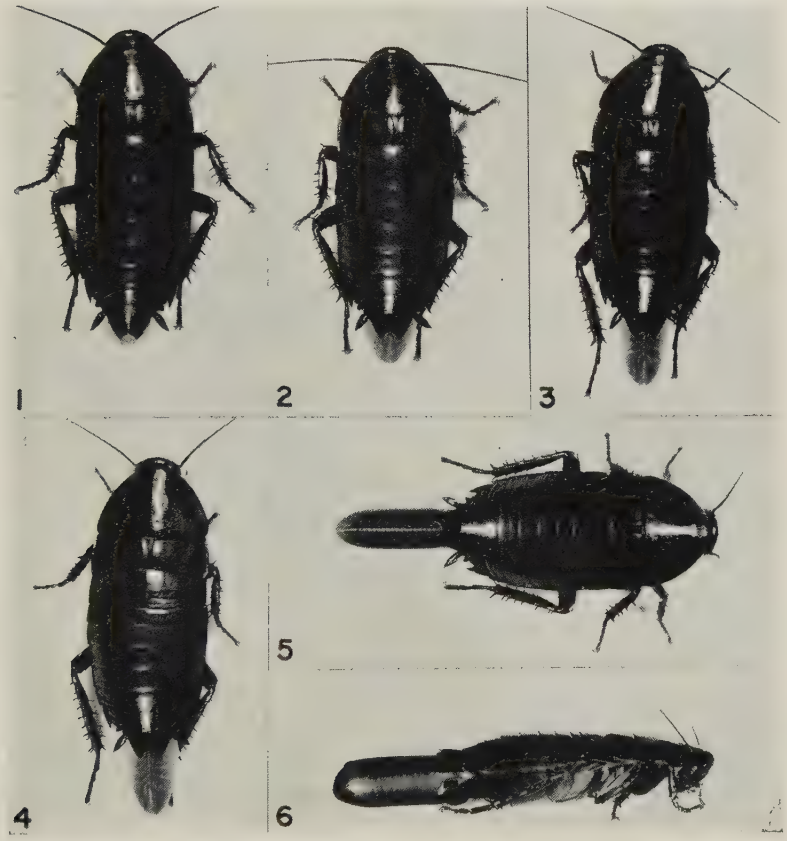
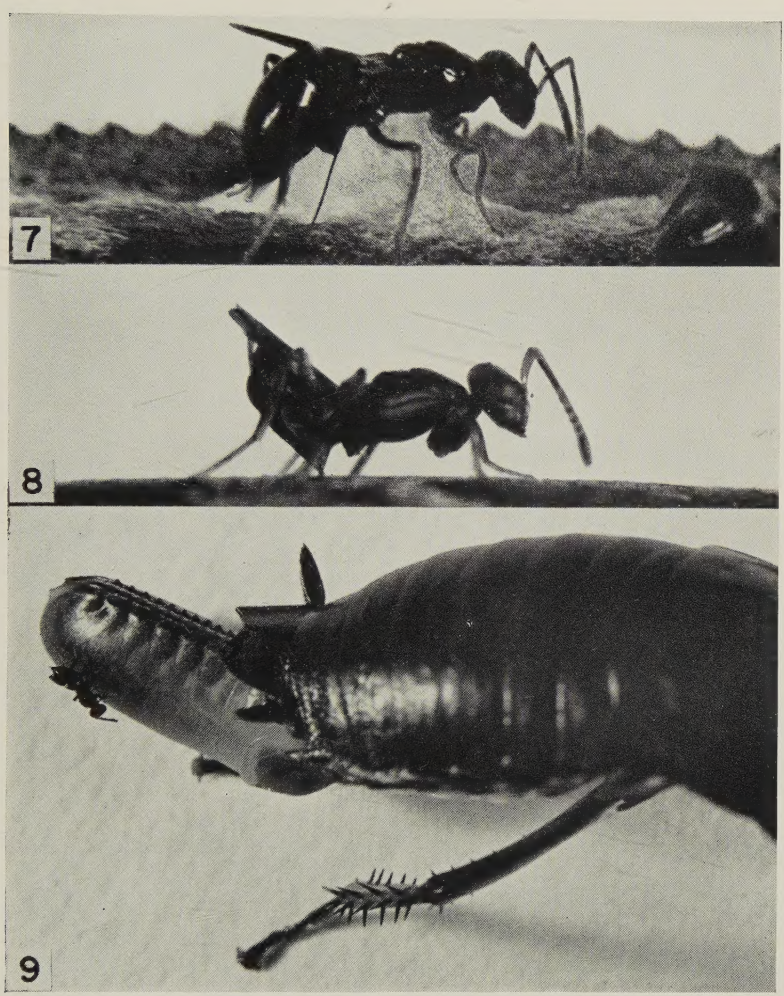


ROTH AND WILLIS—NEW COCKROACH PARASITE



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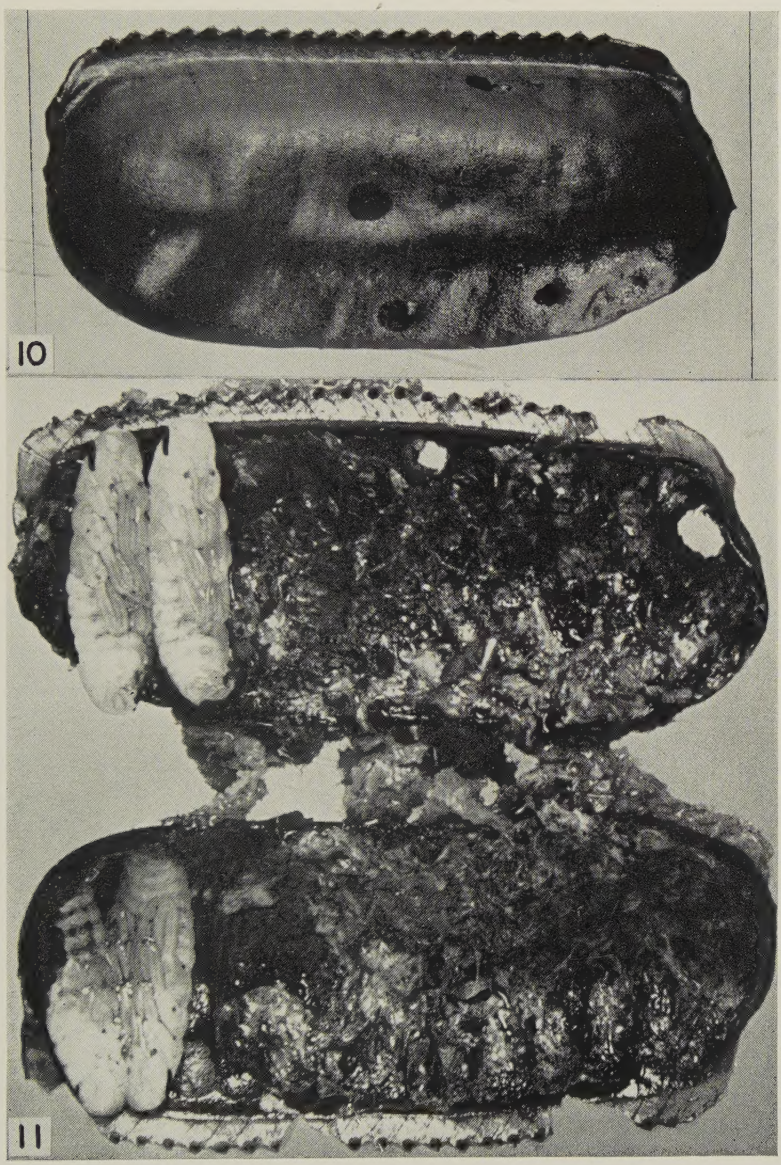

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